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Title: Niowave Flow Testing of the High Power Converter - FY 21

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Niowave Flow Testing of the High Power Converter – FY 21

In Partial Fulfillment of the Deliverable Requirement for Niowave Flow Testing of the High Power Converter Support by LANL

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1 Introduction

Design work for a 100 kW converter to produce a neutron flux via electron impact on a flowing stream of liquid metal lead-bismuth (LBE) was conducted in FY20. In FY21, the focus shifted to a 20 kW converter which was designed in collaboration with Niowave engineers. A flow visualization model is needed to validate model results for the 20 kW converter and ensure adequate coolant flow over containment structures. This work highlights the mockup that was made with quartz side plates by LANL.

The converter design is shown in Figure 1 and consists of a steel plate with a curved "horn" at the top to facilitate LBE flow coming in at a flow rate of 2 GPM, creating a waterfall. The total LBE thickness expected is 9 mm, with a thickness behind the steel plate of 6 mm.

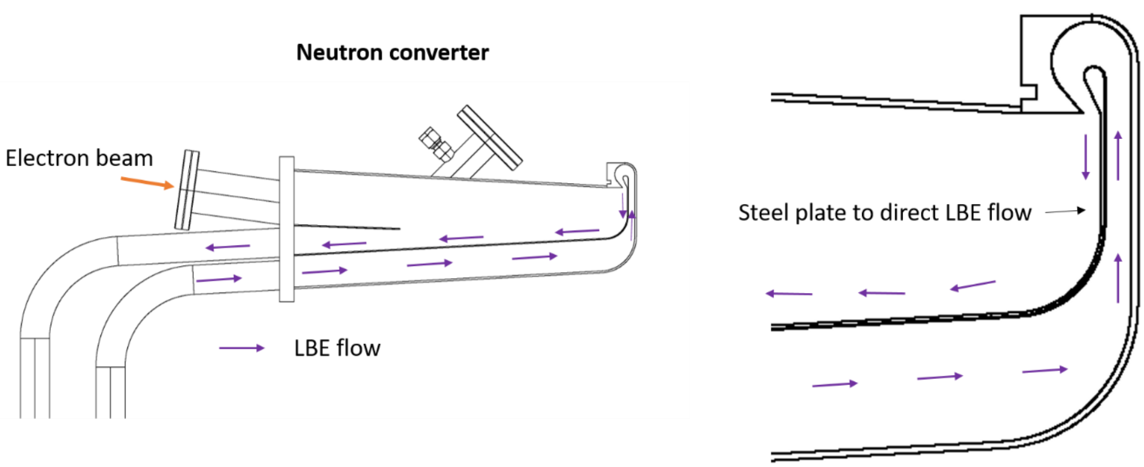

Figure 1: A side view of the Niowave UTA-2 converter creating a 9mm thick lead-bismuth eutectic (LBE) waterfall

2 Flow visualization model

The key parameters that the flow visualization will investigate are the thickness of the LBE at the front of the steel plate, the front facing shape of the waterfall generated by the converter design and whether the LBE waterfall is causing splashing.

In order to visualize the flow, a quartz glass window was added. The window will allow for both a view of the front of the waterfall using an angled camera, the lower portion of the waterfall to observe possible splashing and the side to measure the waterfall thickness. To further enable thickness measurements, inclined notches, 0.5 mm thick were laser etched at 1 mm intervals on the back wall of the LBE.

The model for the flow visualization converter and notch dimensions are shown in Figure 2.

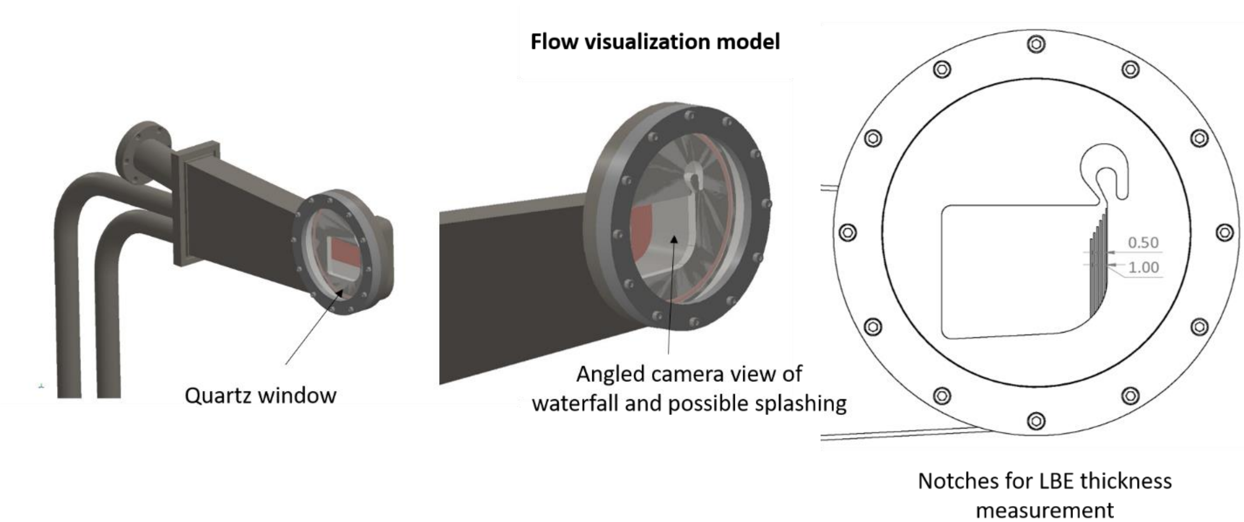

Figure 2: Flow visualization model for LBE

Figure 3 shows the fabricated model for flow visualization testing. A quartz window, which has also fabricated will be placed in the circular cut-out and sealed with a gasket.

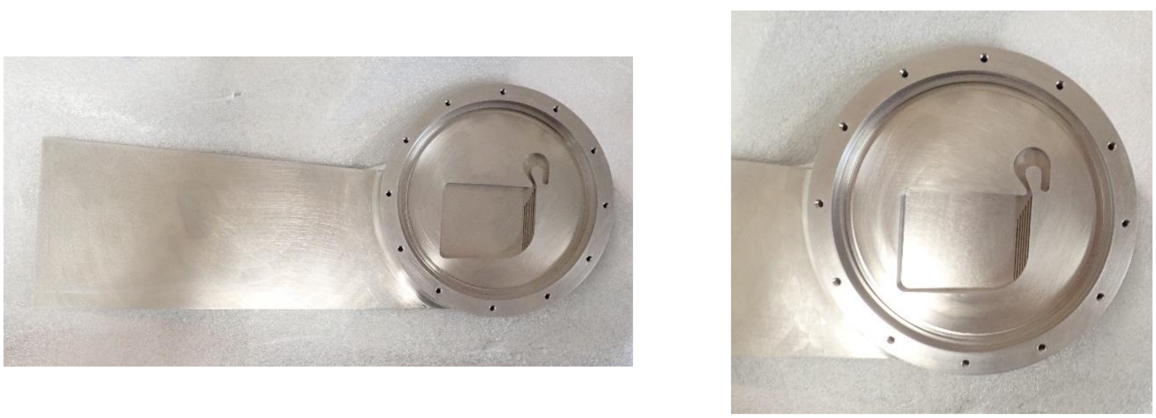

Figure 3: Fabricated flow visualization converter

3 Planned tests

These tests were originally planned to take place at Niowave facilities. However, due to programmatic changes focus shifted to a higher power, 200 kW converter, and the flow visualization tests were cancelled. The flow visualization will instead be tested at LANL facilities using water, matching the Reynolds number and Webber number in separate tests. Once the installation of an LBE test loop is completed, the flow visualization model can be tested using LBE at LANL facilities. Results from these flow visualization tests can inform the design of the 200 kW converter which will consist of LBE flowing at higher flow rates and will be more susceptible to splashing and instabilities on the waterfall sheet.